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COVID-19 Post-Acute Sequela Rehabilitation: A look to the future through the lens of COPD and Pulmonary Rehabilitation

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Running Head: COVID-19 Post-Acute Rehabilitation

Title: COVID-19 Post-Acute Sequela Rehabilitation: A look to the future through the lens of COPD and Pulmonary Rehabilitation

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Abstract

Post COVID-19 condition is characterized by a myriad of persistent symptoms experienced up to 60 days after the acute infection, not just in those hospitalized, but also in patients with mild to moderate acute symptoms. The overwhelming evidence on a multisystem involvement in post COVID-19 condition compounded with its notable prevalence brings to attention the need for integrated delivery models for addressing healthcare needs of this population. The World Health Organization recently highlighted critical gaps in current healthcare delivery models to adequately provide the level of integrative care required to address the multisystem needs of this population and recommended development of new innovative models of delivery. This paper presents a novel approach to addressing these gaps from a rehabilitation perspective.

Keywords: Rehabilitation, telerehabilitation, COVID-19, COPD, integrated delivery system

The COVID-19 pandemic affected approximately 360 million people around the world taking more than 5.6 million lives,¹ with disproportionate illness and poor outcomes experienced by the most vulnerable underserved populations.² In the United States, nearly 14% of patients with COVID-19 were hospitalized, often requiring intensive care, external mechanical ventilation, and intubation due to respiratory failure.³ Respiratory failure often occurred as a result of alveolar injury or pulmonary edema from vascular thrombosis.⁴ As providers learned how to treat respiratory failure among patients hospitalized with COVID-19, survival outcomes improved.

In the early stages of the pandemic, preventing mortality was the priority. Over time, the focus turned to treating people who survived COVID-19 but had persistent symptoms. In 2021, the World Health Organization identified a clinical case definition of persistent sequela after acute COVID infection: post-COVID-19 condition.⁵ Post-COVID-19 condition is characterized by a myriad of persistent symptoms ranging from persistent fatigue, dyspnea, breathing discomfort, and chest pain, to more pronounced ICU acquired weakness, exercise intolerance, neuropathy, myopathy, arthralgia, cognitive impairments, functional decline, and decreased quality of life.⁵⁻¹² Early estimates show approximately 35% of people with COVID-19 illness may experience post-COVID-19 condition.¹³ Moreover, post-COVID-19 condition is not isolated to those with severe symptoms resulting in hospitalization, but also common among people with mild or moderate acute symptoms.

Given the population prevalence and potential for multisystem involvement in post COVID-19 condition, integrated health care models are needed.^{14,15} Furthermore, given the evidence linking health disparities to healthcare access and poorer outcomes, it is critical that post-COVID-19 health care delivery models must meet the needs of underserved populations.² However, the bigger question is whether our healthcare systems are adequately structured for integrative care. The World Health Organization recently addressed this question, and while new innovative models of delivery were recognized as a critical need, no specific models were specified.¹⁰

Research has highlighted that post-COVID-19 condition could benefit from a model of care delivery like pulmonary rehabilitation.¹⁶⁻²⁴ Yet it is not known how to effectively deliver integrated PR across healthcare settings. Using a model of pulmonary rehabilitation for people with chronic obstructive pulmonary disease (COPD), we propose an integrated model of

rehabilitation care with a goal to provide pulmonary rehabilitation to a broad diverse population of need. First, we discuss the need for pulmonary rehabilitation for people who survived COVID-19. Second, we propose an integrative model of delivery that aims to reach a and diverse patient population with post-COVID-19 condition.

Post-COVID-19 Symptom Sequelae: Pulmonary Rehabilitation Implications

Pulmonary dysfunction was among the most prominent early signs of COVID-19 infection..^{25,26} Supplemental oxygen, acute hospital care, and mechanical ventilation were needed for many people with moderate to severe illness.²⁷⁻²⁹ Consequently, COVID-19 respiratory infection and the associated post-acute sequelae are strikingly similar to chronic obstructive pulmonary disease (COPD). Emerging evidence suggests overlapping effects of SARS-CoV-2 infection with COPD including fatigue, dyspnea, and widespread negative effects on skeletal muscle mass, physical function, cognition, and overall conditioning.^{6-8,23,30-34} Decreased physical activity levels, a hallmark of COPD, are present in those with COVID possibly as a result of social isolation and ‘shielding’ as well as from the overall effects of deconditioning from the infection.³⁵ In those with pre-existing pulmonary dysfunction, post-COVID-19 condition could well aggravate the already existing symptoms and accelerate disease progression.³⁶⁻³⁹

Given the overlapping presentation of COVID-19 and COPD, evidence from pulmonary rehabilitation research could provide helpful insights to the post-acute rehabilitation needs of patients with COVID-19.

Pulmonary Rehabilitation

Patients with COPD show significant improvements with pulmonary rehabilitation in their lung function, dyspnea, fatigue, exercise tolerance, overall health status, and quality of life,

and reduced risk of hospital readmissions and mortality.⁴⁰⁻⁴⁴ Pulmonary rehabilitation is defined as “a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and emotional condition of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviors”.⁴⁵ Strong evidence suggests a three-fold improvement in dyspnea, endurance, activity tolerance, and overall quality of life with pulmonary rehabilitation as compared to bronchodilator therapy.^{46,47} Considering the evidence, noninvasive nature, and no side effects, PR has been reported as one of the most effective management strategies to improve health outcomes in COPD.^{44,46,48,49} Early reports of pulmonary rehabilitation in patients with post COVID-19 condition have shown that it is a safe and feasible intervention to improve patient-related health outcomes such as relief of dyspnea and fatigue.^{11,16,19,50-58}

Challenges in PR delivery for post-COVID-19 condition

Despite the emerging evidence on the benefits of pulmonary rehabilitation in post-COVID-19 condition, its implementation presents with some inherent challenges. Pulmonary rehabilitation is typically delivered in specialized hospital or clinical settings that are not widely available. Transportation to these specialized facilities therefore can be prohibitive due to distance or lack of availability.^{48,59} Due to these reasons, access to and utilization of pulmonary rehabilitation has traditionally been low even in those with COPD.⁵⁹ Given the large population impact of post-COVID-19 condition, need for wider distribution of pulmonary rehabilitation would be imperative warranting new approaches to improve access.

The COVID-19 pandemic further heightened the already existing problem of limited utilization of pulmonary rehabilitation. Routine healthcare delivery systems were significantly impacted during the pandemic as all workforce and resources were diverted to treating the acute infection with less attention to the post-acute rehabilitation needs of individuals.⁷ In an attempt to control the spread of the virus, many pulmonary rehabilitation settings were transiently shut down as care providers reallocated workforce staffing or were required to temporarily cease services.^{48,60}

Furthermore, the pandemic required clinicians to quickly transition to some form of telerehabilitation to continue services to patients while maintaining social distancing precautions.⁶¹ Telerehabilitation allows for the delivery of rehabilitation services remotely via the use of information technology such that the provider and patient do not have to be in the same location.⁶² Despite the great promise offered by telerehabilitation, delivery of a completely virtual pulmonary rehabilitation model poses several challenges. First, the successful implementation of telerehabilitation would require resources, technologies, and supports in people's homes possibly requiring substantial investment. For example, delivery of pulmonary rehabilitation virtually would require technology with wider views of the patients' surroundings is possible such as fitting a camera in the patients' homes and telemetric monitoring to capture physiological parameters. Second, simple video conferencing would not allow for a comprehensive assessment of exercise capacity and lung function which are crucial for designing exercise prescription. Finally, given the cost and technology implications, a large number of patients with post-COVID-19 condition from underserved areas, and with limited knowledge of the technology, might not get access to this form of delivery.

Hybrid models of delivery that combine elements of telerehabilitation and traditional onsite care offer a good potential trade-off to ensure accurate exercise prescription and enhance access.⁴⁸ Initial onsite physical examination and assessment followed by remotely supervised sessions could limit travel to pulmonary rehabilitation sites, allowing increased access. Efficacy of hybrid PR intervention approaches, however, is not known.

Integration of Pulmonary Rehabilitation into post-acute rehabilitation settings

Pulmonary rehabilitation is inherently a multidisciplinary approach including but not limited to thorough patient assessment, individually tailored exercise training, education, physical activity counselling, and behavior change to minimize long-term disability. Post-acute rehabilitation facilities such as skilled nursing facilities (SNF), inpatient rehabilitation facilities (IRF), comprehensive outpatient rehabilitation facilities (CORF), and home-health follow an interdisciplinary model of care and are poised to offer pulmonary rehabilitation interventions outside of specialized hospital clinics.

Currently, the rehabilitation delivery for patients with post-COVID-19 condition in the SNFs, IRFs, home, and CORF follows a traditional model more focused on functional mobility and impairments with limited attention to disease-specific pulmonary consequences unique to COVID-19. Integration of pulmonary rehabilitation in these settings would allow for a comprehensive management of patients with post-COVID-19 condition similar to what is provided for COPD. Home-settings could follow one of the following delivery models: a traditional in-person home-based pulmonary rehabilitation, a hybrid model to allow some onsite component for assessments and telerehabilitation, or a fully remote model wherever technological supports are well placed. Traditional in-person hospital-based outpatient pulmonary rehabilitation model of delivery or a hybrid model with some telerehabilitation could

be integrated within CORFs. Inpatient settings would follow a model of delivery similar to the current hospital-based outpatient pulmonary rehabilitation models (Figure I). Integration of pulmonary rehabilitation in post-acute rehabilitation settings would also eliminate the additional step of referral to hospital-based outpatient pulmonary rehabilitation facilities overcoming barriers to access due to failed referrals.

Insert Figure I here

Implementation of this model would require training and supports for the rehabilitation team to deliver evidence-based pulmonary rehabilitation assessment and treatment. An interdisciplinary team of nurses, physical, occupational, and respiratory therapists could be trained to deliver pulmonary rehabilitation to patients with post-COVID-19 condition admitted to these facilities. The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) identify core competencies for pulmonary rehabilitation professionals⁴⁰ and offer certification training in pulmonary rehabilitation.⁶³ These trainings focus on i) pulmonary anatomy, physiology, disease etiology and risk factors, ii) pulmonary specific assessments; iii) application and interpretation of exercise tests; iv) development of individually tailored exercise prescriptions based on exercise testing; v) comprehensive assessment of dyspnea; vi) use of standardized outcome measures, vii) oxygen therapy, viii) interventions focusing on dyspnea relief, inspiratory muscle training, peripheral muscle strength training, aerobic exercise training, and ix) self-management strategies.⁴⁰

Since patients with post-COVID-19 condition may present with multi-system involvement that may require referral to specialized services, disease-specific education on screening for specific complications associated with COVID-19 including new or worsened cardiac impairment, autonomic dysfunction, exertional oxygen desaturation, and orthostatic

intolerance would be crucial.¹² Additionally, patients with post-COVID-19 condition may present with unique problems such as profound muscle weakness,^{16,58} hyperventilation syndrome,¹¹ worsening of fatigue,^{11,16,58} cognitive dysfunction,⁵⁸ psychological distress,¹⁹ and symptom exacerbation that would warrant need for individualized exercise prescription. Hypoxemia and deconditioning may be much worse in those with pre-existing respiratory conditions.¹⁶ Such patients may need pacing of activities and additional caution during exercise progression. By training the rehabilitation team in core competencies of pulmonary rehabilitation and disease-specific considerations of post-COVID-19, the workforce in post-acute rehabilitation facilities would be well equipped not only in managing patients that traditionally qualify for pulmonary rehabilitation such as those with COPD, but also in dealing with a broad range of COVID-19 survivors.⁷

Besides training of healthcare providers in the delivery of pulmonary rehabilitation, post-acute care facilities would require specific equipment and supplies needed for PR such as supplemental oxygen, breathing equipment, inspiratory muscle trainers, self-management and education materials, and telemetric monitoring. These facilities have the space and design conducive to incorporate these resources, making these appealing delivery sites.

Given the 358 million COVID-19 survivors,⁶⁴ the tangible need for comprehensive rehabilitation for patients with post-COVID-19 condition is only beginning to surface. Existing PR facilities are limited in number and may not meet the growing needs of a diverse population with COVID-19. The COVID-19 pandemic exposes the vulnerability of our health care system to deliver integrated care across settings during times of national crisis, but it also creates opportunities to develop alternative comprehensive integrative community-based models of care which could facilitate access to pulmonary rehabilitation across diverse populations. Training the

workforce and preparing post-acute rehabilitation settings for pulmonary rehabilitation could address the needs of a rapidly growing body of patients. Recovery from post-COVID-19 condition will likely continue long after patients discharge from the hospital. Hospital discharge after COVID-19 is not the end of care but the beginning of a long journey of post-acute care. Are we ready?

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Figure Legends

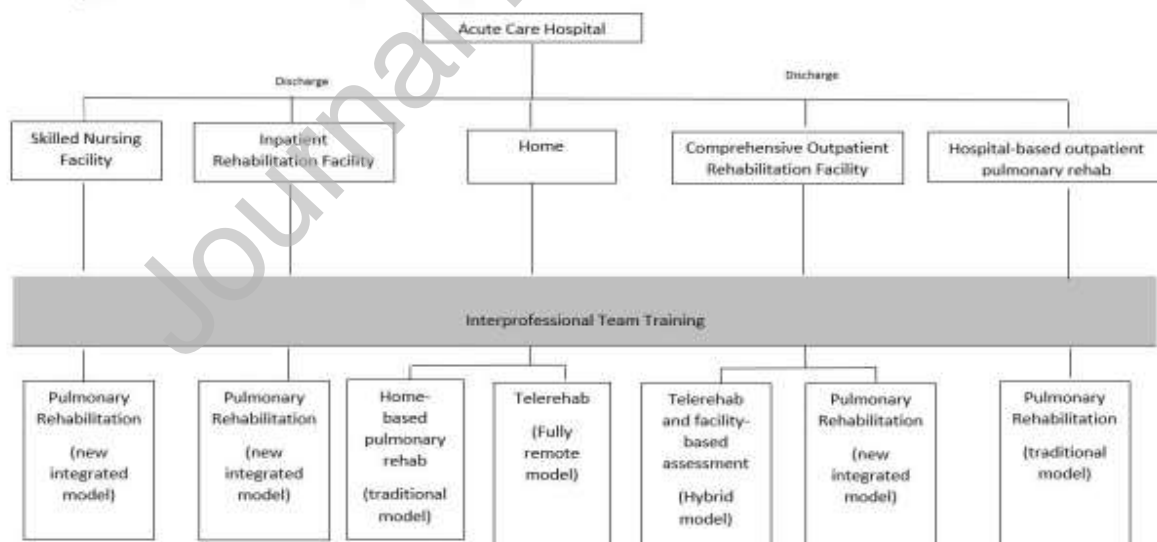


Figure 1: Proposed Model of delivery of Pulmonary Rehabilitation for Patients with post COVID-19 condition